

Northumbria Research Link

Citation: Davenport, Carol, Padwick, Annie, Strachan, Becky, Shimwell, Joe and Horan, Melanie (2020) Tackling the digital and engineering skills shortage: Understanding young people and their career aspirations. In: 2020 IEEE Frontiers in Education Conference (FIE). IEEE, Piscataway, NJ, pp. 1-8. ISBN 9781728189628, 9781728189611

Published by: IEEE

URL: <https://doi.org/10.1109/fie44824.2020.9274242>
<<https://doi.org/10.1109/fie44824.2020.9274242>>

This version was downloaded from Northumbria Research Link:
<http://nrl.northumbria.ac.uk/id/eprint/44757/>

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: <http://nrl.northumbria.ac.uk/policies.html>

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

Tackling the digital and engineering skills shortage: Understanding young people and their career aspirations

Annie Padwick
Engineering and Environment
Northumbria University
Newcastle, UK
0000-0001-9042-0209

Dr. Carol Davenport
Engineering and Environment
Northumbria University
Newcastle, UK
0000-0002-8816-3909

Prof. Rebecca Strachan
Engineering and Environment
Northumbria University
Newcastle, UK
0000-0003-3694

Joe Shimwell
Engineering and Environment
Northumbria University
Newcastle, UK
0000-0003-3211-1541

Melanie Horan
Engineering and Environment
Northumbria University
Newcastle, UK
melanie.horan@northumbria.ac.uk

Abstract— Machines, algorithms and people are coming together in new and exciting ways. This is changing the world of work with new jobs previously unimagined. It is crucial that we prepare our young people for this world, yet many of them do not aspire to, and are not choosing, careers in digital technology or engineering, particularly girls and those from socially-disadvantaged backgrounds. Furthermore, while much of the work in this area has focused on the aspirations of older children there is evidence that children's aspirations are formed at an early age. The aim of this study is to explore the factors that influence younger children's reported aspirations to jobs, and in particular STEM jobs. Data was gathered from children aged 7-11 ($n=622$) across areas of deprivation in North East England. Children were asked about their career aspirations and the motivations behind these. Analysis of this data showed that the majority of children were aspirational in their career choices, with many reporting higher aspirations than their parents' current jobs. A gender difference was evident across both aspirations and motivations, with many girls choosing STEM careers that help others. Very few of the children aspired to jobs in the digital and engineering sectors. These results demonstrate the criticality of early education stages are for children's developing aspirations and the urgent need to adapt education so that all children, irrespective of gender or background, can be supported to grasp the opportunities presented by an ever-changing world.

Keywords— career aspirations, motivations, widening participation, young children, STEM education, digital careers, engineering careers

I. INTRODUCTION

Technology is changing the world and the nature of jobs. The World Economic Forum predicts over 130 million new roles will be created by novel combinations of humans, machines and algorithms [1]. We need to prepare young people for this future, yet many young people are not choosing careers in digital technology or wider science, technology, engineering and maths (STEM) areas and globally, one in five of young people remain unemployed [2]. Additionally, the World Economic Forum estimates that existing employees will need significant reskilling by 2022 to meet an increased technological world [3].

Education is well-placed to support people to access the new skills and learning needed for a changed workplace, including improving the skills needed for the digital and engineering sectors. However, education and training can only go so far. A sustainable future requires a deep understanding

of the barriers, both social and structural, that young people, face, particularly those from groups that have not traditionally chosen to enter these sectors. It also requires new ways of working to support these young people to enable them to view STEM opportunities, particularly digital and engineering, as viable options.

The focus area for this study, North East England, has one of the highest unemployment rates in the UK [4], the highest percentage of 16-24 year olds 'Not in Education, Employment or Training (NEET)' in the country [5], and the lowest rates of participation in full-time Higher Education [6]. The region has been characterised as having low educational and career aspirations [7] or a 'poverty of aspiration' [8]. Once an important hub for traditional industries, engineering, coal mining and manufacture, the region suffered significant losses in the 1980s [9], but is emerging now as a strong performer in digital/creative technology, energy, and manufacturing [10]. These fields require high-level STEM skills, particularly in digital and engineering, yet a shortage in the workforce is predicted [11] and the Strategic Economic Plan for the North-East of England reports a lack of suitable skills [12]. Improving diversity and participation in STEM is a pressing issue not only for the North East of England, but for practitioners, policy makers and researchers in many countries of the world. This includes those transforming their industrial sectors from more traditional forms to those are emerging as challengers in this globally connected world [3].

This paper presents the baseline findings from an educational intervention for children (aged 7-11) from disadvantaged areas, aimed at improving access to the physical sciences, including digital technology and engineering, focusing specifically on the potential barrier of low aspirations. In addressing the research question 'What factors influence children's reported aspirations to jobs, and in particular STEM jobs?', the research team contributes to a greater understanding of how children's aspirations develop. This understanding can be used to develop suitable targeted interventions for opening up and influencing STEM career aspirations among children.

II. BACKGROUND

A. The Development of Aspirations

Aspirations have been defined as the desires, hopes and dreams a person has for their future [14], but also a person's ability to identify and set future goals and be inspired to work towards them in the present [15].

Aspirations begin to form and develop in the early years of a child's life [16] and continue to be shaped by their experience and environment and their understanding of possible careers [17]. The most outwardly visible actions around aspirations are taken when adolescents select routes through education and training and into careers. However, the choices young people make at this stages are already limited by their 'zone of acceptable alternatives', the set of occupations deemed compatible for them at earlier life stages [16]. Gottfredson's Theory of Compromise and Circumscription maintains that children between the age of six and eight years, children begin to limit their occupational aspirations according to their early understandings of masculine and feminine roles. Between nine and thirteen years of age, children further dismiss occupations as out of reach due to their growing awareness of status and hierarchies [16]. By the age of 14 many children relinquish their favored choices and settle for more available and acceptable options, due to their new recognition of external constraints and social circumstances [16][17]. A child's personal characteristics (gender, academic achievement, self-efficacy, motivation etc.) are important influences on their developing aspirations, but children do not operate in isolation, and the characteristics and circumstances of their families, peers, schools, neighborhoods are also key contributory factors [17][18].

B. Aspirations of Young Children

Studies on aspiration tend to concentrate on high school children or adolescents. Far fewer studies have explored aspirations among younger children. It was thought that children's ideas about future careers would be too transitory, or too unrealistic at a younger age to provide reliable results, but studies have shown that aspirations of young children can be explored with success [19][20][21]. Research studies continue to support Gottfredson's theory that children form aspirations early, and create a pool of acceptable alternative futures that are further narrowed down they get older [16], however, the age at which elimination of possible opportunities occurs is now thought to be even earlier than Gottfredson's theory [20][21].

Understanding and supporting the aspirations of young children is particularly important. This is because improving social equity and social mobility requires addressing the root causes of the reduction in possible careers and needs to be done before the child reaches the elimination stage of future possibilities [19][20][21].

C. The 'Raising Aspirations' Narrative

In recent years, UK politicians have shown a high level of policy interest in aspirations as a vehicle for lifting children out of poverty. In the foreword of the 2010 Schools' White Paper the Prime Minister and Deputy Prime Minister note; *"In far too many communities there is a deeply embedded culture of low aspiration that is strongly tied to long-term unemployment"* [22]. This perspective is based on assumptions that children in more deprived areas have lower aspirations, influenced partially by the low aspirations of their parents. Supporting children and their families to raise aspirations is expected to improve their social and economic outcomes [8][19]. Yet, in the 'poverty of aspiration'

perspective, young people themselves shoulder the responsibility for raising their aspirations [23]. An alternative, less judgmental perspective, is to recognize that some social contexts are more conducive to high educational and occupational aspirations than others, and that improving these contexts is the route to increasing life-chances for people living in disadvantaged areas [21][23].

D. Aspirations for STEM

This study categorizes STEM into Core STEM, Medical STEM and STEM-skilled trades generated from the ONS Standard Occupational Classification (SOC) code [24]. Core STEM includes science, engineering, and information and communications technology [25]. Health occupations, which sit within medical STEM, have a lower predicted future skills shortage. Therefore, the focus for this study is aligned to the need for greater numbers of young people to enter the digital and engineering sectors and is therefore based on the Core STEM occupations.

Many children who could aspire to Core STEM pathways, because they have the necessary skills, attainment or interest in the subjects, do not do so. This puzzle has inspired many research studies, both exploring the characteristics and conditions of those who chose core STEM pathways, and the characteristics and conditions of those who hold different aspirations [26][27]. Some science careers have been shown to be 'unthinkable' for young girls, because perceptions of science careers as clever and geeky are not compatible with the girls' ideas of their own femininity or sense of themselves as learners [27]. Exploring digital technology aspirations among digitally-skilled youth, researchers found children were influenced by traditional gendered discourses, with girls rejecting technical digital pathways in favor of creative ones [28]. Children from groups currently under-represented in STEM areas are less likely to see STEM pathways as for 'people like me' [29], and therefore identity and aspiration building in this area is more challenging [30].

E. Intervention

Exploring Extreme Environments is a broad project that supports children's engagement in core science, technology, engineering and mathematic. It combines science, poetry and art linked to the extreme environments found on the sun and in Antarctica to engage and educate children. The project works with children and their supporters (teacher and families) via in class workshops, after school family workshops, assemblies, and teacher CPD sessions. The eight schools involved in the project are in areas of deprivation where there is less experience of how to access opportunities in engineering, digital technologies and other STEM careers.

III. METHODOLOGY

The central research question for this study is 'What factors influence children's reported aspirations to jobs, and in particular STEM jobs?'.

This research question was answered by gathering data from 622 children aged 7 – 11 from five co-educational primary (elementary) schools in areas of deprivation in the North-East of England in the UK. The sample comprised 282 (46%) girls and 334 boys (54%), and included all children

present on the day of data collection, apart from those whose parents chose to opt them out of the research activities. These children were still able to take part in the educational activities related to the project.

The children completed a worksheet in the classroom (containing questions about aspirations, family members' jobs, and demographic information). A sub-set of these children attended focus groups to discuss the same themes with a researcher. Children were asked to complete the questions 'What would you like to be when you grow up?' and then 'Why?'. Additionally children were asked to complete a table responding to the question 'What do your parent(s) / the people who look after you do for work?', providing information about their relatives/carers and their jobs. Children also reported their gender and year group.

Worksheets were tabulated and then coded. Open responses for career aspirations were initially grouped by similar responses e.g. 'cop' and 'policeman' into 'police'. Career aspirations were then coded according to the Standard Occupational Classification (SOC) for the UK [24], and then into core STEM and medical STEM, STEM-skilled Trades and non-STEM jobs [25]. Some aspirations could not be coded, either due to the illegibility of the response on the worksheet or because the job could not be considered a job according to the SOC (e.g. happy man, princess). Open responses to the 'why?' questions, the reasons children would like to do these jobs, were reviewed initially to determine categories and then coded according these broad and more specific categories (see Table 3). The job roles of children's close relatives/carers were also coded by the Standard Occupational Classification for the UK.

Qualitative analysis was conducted in IBM SPSS Statistics 15. Descriptive statistics were used for frequency counts of reported aspirations and the rationale.

IV. RESULTS

A. Children's Careers Aspirations

98% of children reported at least one career aspiration on their worksheet. Of 622 children were each able to provide three aspirations, 1355 aspirations and associated reasons were recorded, showing that young children in this sample did not present challenges thinking about and reporting their future job aspirations. The analysis found a relatively narrow pool of 82 different career aspirations, with just 20 of these accounting for 75% of all those reported. Figure 1 shows the most popular 20 jobs by gender. Although some aspirations are popular among both girls and boys, their career aspirations are different overall, and are consistent with traditional ideas of male and female jobs: very few boys report aspirations in hair and beauty or nursing, and very few girls report aspirations in the armed forces, firefighting or construction.

Children did not report low career aspirations (Table. 1). Of the classifiable aspirations, 81% were in the top three categories of the Standard Occupational Classification (SOC), and 50% fell into SOC 3, the classification for

TABLE.1. No. AND % OF CHILDREN REPORTING ASPIRATIONS IN SOC MAJOR GROUPS WITH POPULAR JOBS

	<i>SOC Major Groups</i>	<i>No.</i>	<i>%</i>	<i>Popular responses within group</i>
1	Managers and Senior Officials	30	2	military commander, business owner, shop owner
2	Professional Occupations	318	26	teacher, vet, scientist, doctor, nurse, programmer
3	Associate Professional and Technical Occupations	645	52	footballer, youtuber, teacher, police, sport other, artist, actor, musician, firefighter
4	Administrative and Professional Occupations	14	1	civil servant, cashier
5	Skilled Trade Occupations	71	6	chef/cook, builder, farmer, baker, mechanic, electrician
6	Caring, Leisure and Other Service Occupations	105	9	hair and beauty, animal care, child care, carer
7	Sales and Customer Service Occupations	17	1	shop worker
8	Process, Plant and Machine Operatives	10	1	bus driver, train driver, taxi driver, delivery driver
9	Elementary Occupations	19	2	fast food worker, café, bartender

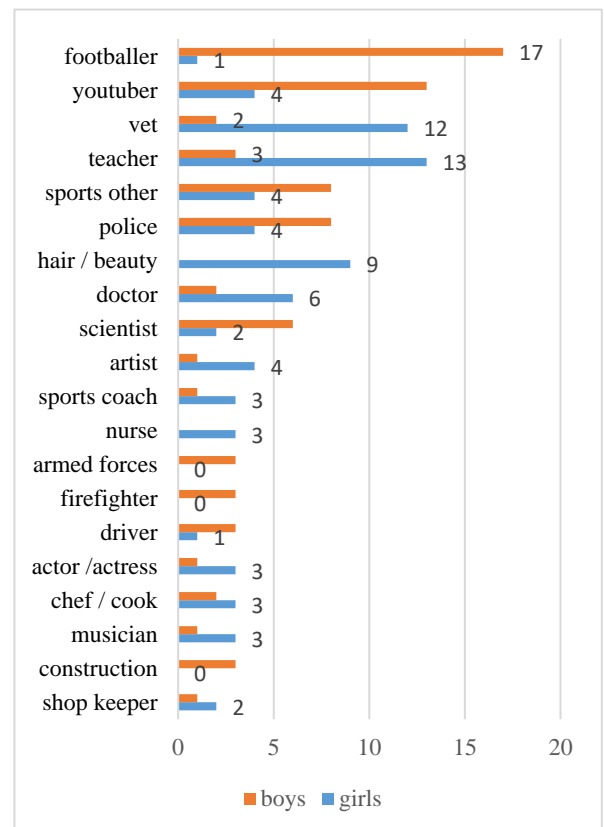


Fig. 1. Children's top 20 career aspirations by gender

associate professional and technical occupations. This category includes the majority of culture, media and sports occupations and protective service occupations and therefore includes some of children's most popular jobs such as 'footballer', 'sport other', 'youtuber' and 'police'. 26% of children reported aspirations within Professional Occupations (SOC2), which includes teaching, core STEM and medical STEM jobs. Only 3% of children's reported aspirations could be classified in the bottom two categories of the SOC, where no formal education is required. Children had higher aspirations than their parent's current jobs, with only 21% of reported jobs categorized in the top 3 SOC classifications, 58% in the middle four SOC categories and 21% in the bottom two categories of the SOC, where no formal education is required.

Analysis of the SOC Classifications Hierarchy by gender (Table. 2) finds that although both girls and boys report high aspirations, there are some differences. More girls report aspirations within Professional Occupations (SOC 2) and SOC 6 (Caring, Leisure and Service Occupations (SOC 6) than boys, whereas more boys report aspirations within the Associate Professional and Technical Occupations (SOC 3) and Skilled Trade Occupations (SOC 5) than girls.

B. Reported Reasons for Aspirations

A variety of reasons were reported in response to 'Why?' children would like to pursue their chosen aspirations. These were grouped into seven general categories and 29 specific linked categories, see Table. 3. Among the general categories, the most commonly cited were enjoying an aspect of it (35%), helping others (21%) and achieving a personal goal (15%).

Further analysis revealed differences between the genders, with girl's reasons more aligned to 'enjoying an aspect of it' and 'helping others' than boys, and boys more aligned to 'achieving a personal goal' than girls (Figure 2).

C. Children's Career Aspirations in Core STEM

304 STEM aspirations were reported, comprising 31 different job roles within STEM fields. 39% of the 622 children surveyed reported at least one STEM aspiration and

TABLE 2. PERCENTAGES REPORTING ASPIRATIONS IN SOC HIERARCHY BY GENDER

SOC Major Groups		% of which boys	% of which girls
1	Managers and Senior Officials	3	1
2	Professional Occupations	17	39
3	Associate Professional and Technical Occupations	65	39
4	Administrative and Professional Occupations	0	1
5	Skilled Trade Occupations	8	2
6	Caring, Leisure and Other Service Occupations	4	14
7	Sales and Customer Service Occupations	1	2
8	Process, Plant and Machine Operatives	1	1
9	Elementary Occupations	2	1

TABLE 3. NO. AND % OF CHILDREN REPORTING REASONS FOR ASPIRATIONS

Gen. Cat.	No.	%	Specific Cat.	No.	%
enjoy aspect of it	473	35	like animals	53	4
			like topic	102	7
			enjoy it	131	10
			like hobby	178	13
			passion	9	1
achieved success in it	139	10	do it already	50	4
			good at it	89	7
job looks good	194	14	looks good	87	6
			to do exciting aspect of the job	87	6
			it's a good job	11	1
			looks easy	1	0
			thrill	8	1
achieve personal goal	210	15	achieve ambition	41	3
			learn /be better	35	3
			money / fame / respect / popularity	85	6
			travel/ explore/ independence	27	2
			make me happy	6	0
			to be healthy	11	1
			to get something	5	0
to help others	283	21	help people	197	14
			help animals	55	4
			make people happy	20	1
			make people look good	6	0
			inspire others	5	0
inspired by	56	4	like family/ others	45	3
			inspired by experience	3	0
			inspired by media	8	1
other	9	1	because I want to	9	1

of these, 22% reported two or more STEM aspirations. Comparing children's choices across their three aspirations, we see children in this age group (7-11) children have not narrowed down their choices to just those within STEM fields, and aspirations to be a scientist sit comfortably alongside aspirations to become a singer or a dancer.

The STEM aspirations were grouped into Core STEM, Medical STEM and STEM-skilled trades. The breakdown of these groupings can be seen in Table. 4, with Medical STEM being the most popular group of STEM aspirations, particularly amongst girls. 110 Core STEM aspirations were reported, accounting for 36% of the STEM aspirations. The Core STEM jobs category includes engineering and digital

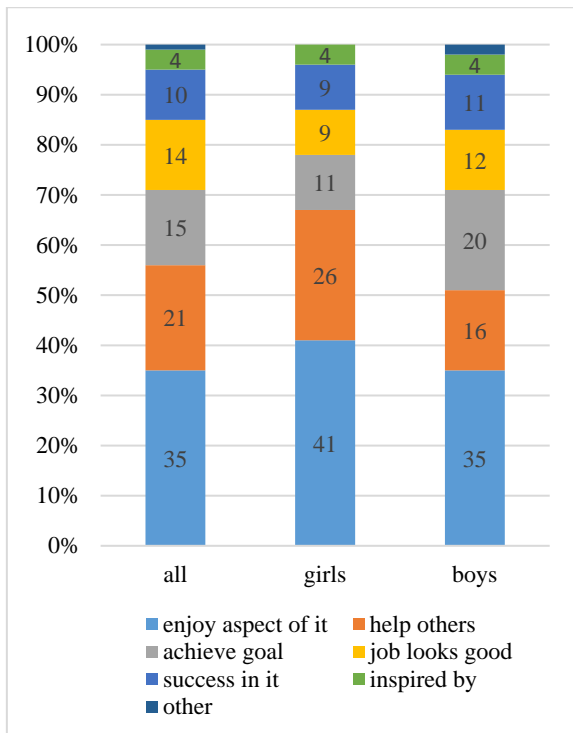


Fig. 2. Children's Motivations for General Aspirations

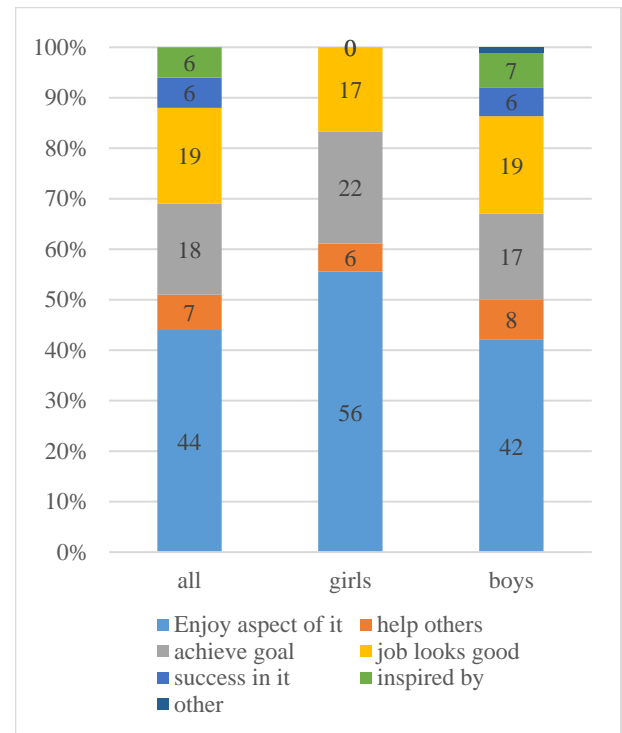


Fig. 3. Children's Motivations for CORE STEM Aspirations

technology jobs, but also chemical, biological, and physical scientists; conservation and environment professionals; architects, town planners and surveyors; telecommunications professionals; production managers and directors; pilots; research and development managers; technicians; and health and safety officers. The large majority of Core STEM jobs (86%) are categorized as SOC 2 for Professional Occupations and the remainder were either SOC 3 or SOC 5. Core STEM aspirations can therefore be defined as high. Within the Professional Occupations category, reported aspirations include scientist (30, 33%), in digital technology (17, 19%), and engineer (12, 13%). Interestingly, within digital technology jobs, all but two of 17 aspirations reported were within the games industry: game developer, game tester, etc.

Analysis by gender (Table 4) shows that 83% of the Core STEM jobs were reported by boys, and only 17% by girls. Looking specifically at the engineering and digital technology jobs specifically, we see that only one girl reported an aspiration as an engineer, and no girls aspired to careers in digital technology. This pattern seems to be repeated among STEM-skilled trades, where 83% of these were reported by boys and only 17% of these by girls. In contrast, this pattern is reversed for Medical STEM

TABLE 4. BREAKDOWN OF STEM GROUPS WITH % OF WHICH REPORTED BY GENDER

STEM Group	No.	%	% of which girls	% of which boys
Core STEM	110	36	16	84
Medical STEM	182	60	81	19
STEM-Skilled Trades	12	4	17	83

aspirations, where 81% of the Medical STEM aspirations were reported by girls, and only 19% by boys. This category includes all health-related roles, and high percentages of children reported aspirations as a vet (49%), doctor (30%) and nurse (10%).

D. Reported Motivations for Core STEM Aspirations

Analysis of the motivations children reported for STEM careers aspirations in Figure 3 shows the proportion of children reporting each reason for Core STEM aspirations. Both girls and boys provide the same reasons for their motivations for Core STEM in similar proportions, with a large majority of children with STEM aspirations given reasons included within 'enjoy an aspect of it' (44%), high numbers of children also report the reasons 'the job looks good' (19%) and 'to achieve a personal goal' (18%). Only 7% of aspirations were aligned with the reason 'help others'.

Looking more closely at the reasons given within the general category 'enjoy an aspect of it', 40 children (85%) reported reasons aligned with the specific category 'like the topic'. This category included responses around liking the subject science, or enjoying learning it, liking an aspect of science (space, dinosaurs, sea creatures), or having a curiosity for it "*I am curious*", or enjoying related skills "*I like to experiment and to test*". Analyzing reasons given within the general category 'the job looks good', many of the specific reasons aligned with 'to do an exciting aspect of the job', and children reported a particular aspect of the job they would like to do, "because you can make machines", "because you dig up old stuff and find fossils of dinosaurs". Some other specific category reasons in this group were linked to 'looks like a good job'; with children's responses including statements like "*it's a good job for me*", "*because it will be a good experience*" and "*you get treated extremely well*". Within the general category 'to achieve a personal goal', the

largest group of responses were within the specific category ‘to achieve an ambition’, where children’s responses include creating something brilliant such as “*making game ideas I like the idea of*” “*building my own house*”, “*making discoveries*”. Other motivators were travelling and exploring, for example “*because you will go to the moon*”. Children’s Core STEM motivators rarely included money, fame, popularity or respect.

This study found that motivations for engineering jobs were linked to ‘enjoyment of the topic’, desire to create things, or because a family member already works in the field, e.g. “*my dad takes me out with him and he is one and I enjoy it*”. However, as the number of children reporting engineering aspirations was low (12 children), the sample size is somewhat limited. For digital jobs motivations were mixed, including that the ‘job looks good’, ‘the have achieved success in it’ e.g. “*I like making games with C#*”, they ‘enjoy an aspect of it’ and also ‘helping others’ e.g. “*to make people happy*” and “*to keep people entertained*”. Though again the sample size of motivations for digital technology jobs was low (17 children).

To provide contrast, the motivations reported for Medical STEM roles were also explored. The largest general category in Medical STEM is ‘help others’ (66%), and then ‘enjoying an aspect of it’ (24%). Looking at the specific categories within ‘help others’, this was subdivided into ‘to help people’ (57%) and ‘to help animals’ (43%), aligning with the high numbers reporting aspirations to be a vet. Looking at the specific categories within ‘enjoying an aspect of it’, the predominant category was ‘like animals’ accounting for 86% of responses. Again the numbers are small, but when analyzed by gender, as shown in Figure 4, we see the same motivators for choosing Medical STEM for both males and females, and in similar proportions.

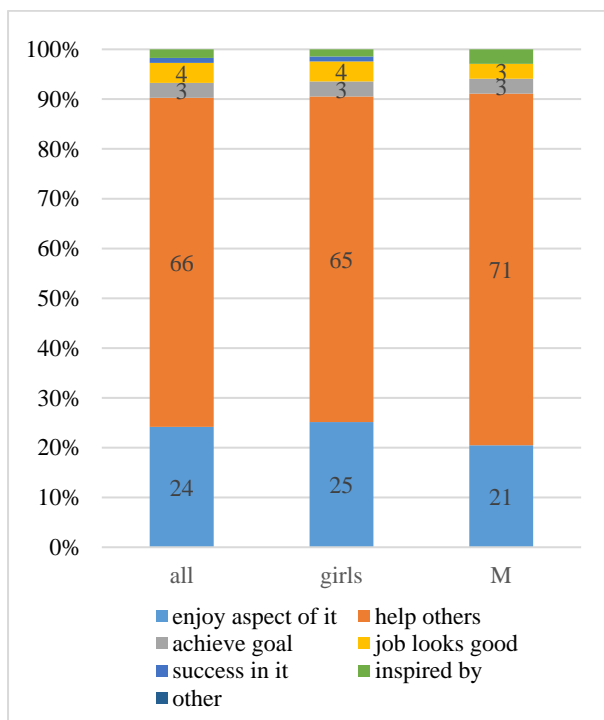


Fig. 4 Children’s Motivations for Medical STEM Aspirations

V. DISCUSSION

Contrary to the ‘poverty of aspiration’ narrative favored by politicians, this study evidences that young children in areas of deprivation in the North-East of England have high aspirations for their futures. The large majority of children report ambitions for professional occupations, or associate professional and technical occupations, and have ambitions higher than the current jobs of family members. This finding is mirrored by a number of studies which have found that children in poverty have high occupational aspirations for themselves and that parents living in poverty also have high aspirations for their children [13][21]. The challenges faced however are the gaps in knowledge or experiences needed to realize these aspirations [23]. Additionally, the study finds evidence that over a third of the children aspire to jobs within STEM fields, of which the large majority of which can be classified as ‘high aspirations’ due to their classification as Professional Occupations in the SOC.

This study asked children to name (up to) three of their future aspirations, in a methodology that enabled the researchers to uncover the scope of children’s aspirations at this young age. Children’s zone of acceptable alternatives [16] reported among 7- 11 year olds is broad, with individuals reporting aspirations across a variety of career sectors and occupational classifications simultaneously. For example, one child who had ambitions as an engineer also would like to be an actor, and another child with ambitions as a game developer would also like to be a footballer. However, consistent with the Theory of Circumscription and Compromise, the children studied have entered the orientation to gender roles phase, and have begun to view occupational aspirations through a gender lens [16]. Societal influences, perceptions of gender and acceptability of careers, have already stratified children’s aspirations into traditionally male or female dominated sectors and jobs, and so that only 17% of girls aspire to Core STEM jobs compared with 83% of boys. Similarly, only 20% of boys reported aspirations to Medical STEM roles, in comparison with 80% of girls. Furthermore, this study finds that six times the number of girls want to become vets, and three times the number of girls want to become teachers, compared to boys. The finding that girls favor the ‘nurturing’ STEM roles is consistent with other studies in this area for older children and young people [21] [28] [30]. This study adds to the literature by showing the very early age that such preferences first take place, and that by age 7, many girls have already begun to see careers in engineering or digital technology as unacceptable.

However, the study also shows it is still possible for children to form aspirations for jobs that counter traditional stereotypes at this young age (7-11). Girls who have aspirations outside the norm labelled them as such in their responses, “*lady chef*”, “*taxi girl*”, “*police girl*” and “*girl’s footballer*”. Within one of the linked focus groups for this study we find an example of this in Chloe, age 9. Chloe likes art and science, and would like to be an engineer or a teacher when she is older. She describes her interest in engineering, but recognizes this is against the expectations for her gender, “*My dad’s an engineer. I want to do a lot of the more boy*

things because I like them. I like to do more like the building things.”

Analysis of children’s motivations for their aspirations shows that these are different within different STEM sectors. Those who have aspirations for Core STEM jobs are largely motivated by enjoyment of the subject or topic, enjoyment of related skills, or desire to continue to exploring these topics or skills. The small proportion of females with Core STEM aspirations display similar motivations as males.

ASPIRES 2 [13] found that those young people who aspired to engineering careers (Core STEM) were more likely to be motivated by a desire to earn a lot of money, create things and make a difference in the world. Interestingly, only the desire to create things was shared by the children in this study. Conversely, motivations for Medical STEM aspirations are dominated by children’s desire to help people, help animals and because they like animals, which perhaps links with the motivation to ‘make a difference in the world’ found by ASPIRES. Again the small number of boys with aspirations for Medical STEM share the same motivations to ‘help others’ as girls. It is clear that motivations do not cut clearly along gender lines, but children’s motivations, and the value they see within a job, is an important indicator of their future career aspiration. Eccles [31] found that the primary reason women are less likely to go into engineering and physical sciences than men is because they are more motivated than men to want to do jobs that directly help people. Because of this, doing a job within the physical science and engineering would not hold the same job value.

Children in this study may not yet have begun the circumscription phase, usually found among children between 9 and 13, where children begin the progressive elimination of their least-favored alternatives [16]. At this stage we can expect children’s ‘zone of acceptable alternatives’ to further narrow as a result of children’s growing awareness of social status, hierarchy and available opportunities within their area. Similarly, adolescence is a key time for asking questions of oneself and one’s identity [31]. Tan et al describe the ‘identity gap’ displayed in middle school girls with an interest in and aspiration for STEM, who find it challenging to reconcile their identities of - who they are and who they want to be - within science classes This ultimately leading to many girls turning away from STEM during adolescence [30]. Chloe’s identities currently include art, engineering and singing, but negotiating these different, and perhaps contradictory identities as she gets older may prove more of a challenge. ASPIRES initial study found that girls who aspired to science careers at age 10/11 that also identified as ‘girly’ tended to drop or change these aspirations over time [34].

Prior studies have questioned whether it is possible to collect meaningful data on younger children’s career aspirations [21]. This study has demonstrated that young children (aged 7-11) do not have difficulties in reporting their future career aspirations and the motivations for these. Equally, ASPIRES 2, a longitudinal monitoring children’s aspirations from age 10 to 18, has found that patterns of aspiration are relatively consistent across the whole period,

with children reporting aspirations in a similar fields over five data points [13]. While it is unlikely that at age 9 a child will report the exact career they will do later on in life, it is likely they may pursue one within a similar field or area, or with similar motivations.

VI. LIMITATIONS AND FUTURE WORK

The research study reported here was limited in geographical and socioeconomic scope. The sample was drawn from five schools all situated in areas of deprivation in the North East of England. It is therefore possible that the patterns of career aspirations uncovered by the study may not be generalizable to a wider demographic. However, the broad trends identified in the data are similar to trends seen in other studies linked to older children [13] [23] [34] and in other regions [29] providing some confidence in the findings.

The research instrument for this study consisted of a worksheet that required children to write their answers. This requirement meant that those children with low levels of literacy might have been discouraged from completing the worksheet. This was seen in some cases, where the quality of a child’s handwriting precluded the inclusion of their answer in the data. However, only 6 pupils did not write down any aspirations and 3 pupil’s aspirations were indecipherable, so it does not appear that literacy demands were a limitation to participation in the project.

The data presented in this paper present a ‘snapshot’ of young children’s aspirations at one point in time and as part of the broader engagement project. Aspiration data will be collected from the same children at the end of the three-year project to explore the impact of participation in the project on children’s career aspirations.

VII. CONCLUSION

To meet the challenges of an increasingly technological world, we require new generations of young people firstly to aspire to STEM careers and secondly, to have the support and backing to continue STEM-identities and aspiration. The North East of England Local Authority Partnership announced areas of strategic importance in digital and advanced manufacturing [10], but also acknowledges a likely be a shortage of people with suitable skills, based on current predictions [12].

Out of 622 children and 1355 aspirations, this study found only 17 children with aspirations for digital technology and 12 with aspirations for engineering. Children’s early aspirations affect their subsequent decisions and in turn their range of available pathways [35]. Therefore, the best time to support children to develop aspirations for STEM careers, particularly in engineering and digital technology, is when they are still young, and whilst they are forming ideas of masculine and feminine roles, attributes and values. Educators working with young children are well-placed to support this development, but the influences of societal norms and expectations should not be underestimated.

REFERENCES

- [1] World Economic Forum: Insights Report. "The Future of Jobs 2018 Report", 2018.
- [2] S. Kühn, "Global employment and social trends". World Employment and Social Outlook, 2019.
- [3] T. Leopold, V. Ratecheva, S. Zahidi, "The Future of Jobs: Employment, Skills and Workforce Strategy for Fourth Industrial Revolution". World Economic Forum, 2016.
- [4] Office for National Statistics, "Regional Labour Market Statistics – December", 2015. Available www.ons.gov.uk.
- [5] A. Brown, "NEET: Young People Not in Education, Employment or Training, Briefing Paper". House of Commons Library, 2018.
- [6] HEFCE, "Trends in Participation". 2013. Available www.hefce.ac.uk.
- [7] Government Office North East, "Helping young people achieve their aspirations. A statement of priorities for the North East. Consultation document (draft). Government Office North East. 2004.
- [8] P. Vardy, "Poverty of aspiration is barrier new business creation in the North East". [An address to the "Entrepreneurship in the North East - Rethinking high value business creation" workshop organised by North East Regional Information Partnership]. 3 November, 2006.
- [9] C. Hodgson, D. Charles, "Case Study – North East England (UK) Work Package 4: Structural Change and Globalisation". KITE for European Commission Directorate General Regional Policy, 2008.
- [10] North East LEP, "Areas of business growth opportunity". 2020. Available www.northeastlep.co.uk.
- [11] UK Commission for Employment and Skills (UKCES), "Reviewing the requirement for high level STEM skills." , 2015. Available: assets.publishing.service.gov.uk.
- [12] NELEP, "North East Strategic Economic Plan", 2019. Available: www.northeastlep.co.uk.
- [13] L. Archer, J. Moote, E. Macleod, B. Francis, J. DeWitt, "Aspires 2: Young People's Science and Career Aspirations age 10 -19". London: UCL. Institute of Education, 2020.
- [14] S. Gorard, S. See, B. H., & P. Davies, "The impact of attitudes and aspirations on educational attainment and participation". York: Joseph Rowntree Foundation, 2012.
- [15] R. Quaglia, C. Cobb, "Toward a theory of student aspirations. Journal of Research in Rural Education", 12(3): 127-132. 1996.
- [16] L. Gottfredson, "Circumscription and compromise: A developmental theory of occupational aspirations". Journal of Counseling psychology, 28(6), 545. 1981.
- [17] G. Leslie, and R. Akerman. "Determinants of aspirations [wider benefits of learning research report no. 27]". Centre for Research on the Wider Benefits of Learning, Institute of Education, University of London. 2008.
- [18] L. Archer, J. DeWitt, J. Osborne, J. Dillon, B. Willis, and B. Wong. "Science aspirations, capital, and family habitus: How families shape children's engagement and identification with science." American Educational Research Journal 49, no. 5. 881-908, 2012.
- [19] M. Hutchings, "What will you do when you grow up? The social construction of children's occupational preferences", Children's Social and Economics Education, 1996.
- [20] E. Flouri, D. Tsivrikos, R. Akhtar, E. Midouhas, "Neighbourhood, school and family determinants of children's aspirations in primary school". Journal of Vocational Behavior, 87, 71-79, 2015.
- [21] N. Chambers, J. Rehill, E. Kashefpakdel, C. Percy, "Drawing the Future", Education and Employers, 2008.
- [22] DfE, "The importance of Teaching: Schools White Paper". Cm 7890. London, 2010a.
- [23] K. Kintrea, R. St.Clair, M. Houston, "The influence of parents, place and poverty on educational attitudes and aspirations", Joseph Rowntree Foundation, 2012.
- [24] ONS, "ONS Standard Occupational Classification SOC Hierarchy", https://onsdigital.github.io/dp-classification-tools/standard-occupational-classification/ONS_SOC_hierarchy_view.html, 2010.
- [25] WISE, "The Office for National Statistics SOC", 2018. Available www.wisecampaign.org.uk.
- [26] A. Diekmann, E. Brown, A. Johnston & E. Clark, "Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers". Psychological science, 21(8), 1051-1057, 2010.
- [27] L. Archer, J. DeWitt, J. Osborne, J. Dillon, B. Willis, B., B. Wong. "'Not girly, not sexy, not glamorous': Primary school girls' and parents' constructions of science aspirations". Pedagogy, Culture & Society, 21(1), 171-194, 2013.
- [28] B. Wong, P. Kemp, "Technical boys and creative girls: the career aspirations of digitally skilled youths". Cambridge Journal of Education, 2017.
- [29] A. Macdonald, "Not for people like me?" Under-represented groups in science, technology and engineering. Wise Campaign. Nov, 2014.
- [30] E. Tan, A. Calabrese Barton, H. Kang, T. O'Neill, "Desiring a career in STEM - related fields: How middle school girls articulate and negotiate identities - in - practice in science". Journal of Research in Science Teaching. Dec;50(10):1143-79, 2013.
- [31] J. Eccles, "Who am I and What Am I Going to Do with My Life? Personal and Collective Identities as Motivators of Action, 2009.
- [32] CRFR, "Can we put the 'poverty of aspiration' myth to bed now", Centre for Research on Families and Relationships, Research Briefing 91, 2017.
- [33] S. Powell, "Exploring the education and employment aspirations of young women in the North East of England". Phd Thesis, 2011. Available www.semanticscholar.org.
- [34] L. Archer, J. Osborne, J. DeWitt, J. Dillon, B. Wong, and B. Willis, ASPIRES: young people's science and career aspirations, age 10-14, King's College London, London, 2013.
- [35] R. Tai, C. Liu, A. Maltese, X. Fan, "Planning early for careers in science". Science. May 26;312(5777):1143-4, 2006.